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THE MOULT OF THE NORTH AMERICAN SHORE BIRDS (LIMICOLÆ).

BY DR. JONATHAN DWIGHT, JR.

THE Limicolæ of North America constitute a large group of closely related species which also greatly resemble each other in their successive plumages and moults. Probably the best known of them are the Sandpipers, Yellow-legs, Curlews, Plovers, and others included under the popular name of 'Bay-snipe' which frequent our seashores, although the Woodcock and the Snipe may be more familiar acquaintances to the average sportsman. They are all birds of strong flight, and the bulk of them, breeding in Arctic regions, push southward in flocks in the autumn and again northward in the spring. In their migration many of them cross the equator in both hemispheres, some even reaching Patagonia and South Africa. As a result of this long line of migration, in some species, thousands of miles in length, they appear to tarry but for a brief period on the journey, so that in most cases we know little of their plumages other than their migration dress, and still less of the moults by which changes are effected. In fact, so little has been known that belief in extensive color changes in old feathers, especially in cosmopolitan species, has prevailed, although such belief now proves to be groundless because contrary to facts which, it may be said, are none too well known. The reasons are not far to seek. There is a great scarcity in collections of birds which show actual moult, and there is an even greater scarcity of adults in winter plumage, so it has escaped notice that young birds and old, after a certain period in the fall, are practically indistinguishable, and, what is more, males and females assume an almost identical plumage. This sometimes renders difficult an explanation of the midwinter moult which takes place, apparently in all species. It is undoubtedly complete, to the flight-feathers and tails in most young birds, and apparently is confined to the body-feathers in adults, although it is possible that some species undergo a complete moult in adults as well as young.

Such evidence as I have been able to gather is derived from specimens in my own collection where age and sex have been determined by dissection, and from large series of skins in the American Museum of Natural History and the U. S. National Museum, which have been kindly placed at my disposal by the respective curators, Dr. J. A. Allen and Prof. Robert Ridgway. Of a few species I have examined birds taken almost every month in the year, but every attempt to link together the successive plumages is much like trying to read a book from which stray pages have been torn. However, I find that what is true of Passerine birds and of the Grouse is equally true of the Shore Birds, viz., that *Every species has a definite sequence of plumages and of moults, the plumages being modified by wear and changed by moult.*

This principle of sequence of plumages, which I have explained at length in previous papers, is illustrated by a scheme of plumages and moults which was originally laid out for Passerine species (Annals N. Y. Acad. Sci., XIII, 1900, p. 104) but it is equally applicable to the Shore Birds. It shows the plumages in their natural sequence followed by the moults that occur, unless suppressed, as they are in some species, and it is as follows:

1. Natal Down.	1. Postnatal Moult.
2. Juvenal Plumage.	2. Postjuvenal Moult.
3. First Winter Plumage.	3. First Prenuptial Moult.
4. First Nuptial Plumage.	4. First Postnuptial Moult.
5. Second (or Adult) Winter Plumage.	5. Second (or Adult) Prenuptial Moult.
6. Second (or Adult) Nuptial Plumage, etc.	6. Second (or Adult) Postnuptial Moult, etc.

Later plumages would be 'winter' and 'nuptial,' followed by 'prenuptial' and 'postnuptial' moults. This scheme furnishes definite terms which are almost indispensable for a proper explanation of the plumage changes which regularly occur as birds pass from immature to adult dress and from summer to winter plumages.

In many species of the Shore Birds, plumage differences between young and old are lost at an early period. All adults at the postnuptial moult assume a plumage that in one class of

birds is often indistinguishable from the juvenal, in another indistinguishable from the first winter dress, the difference being in the young birds. The first class of young birds retains the juvenal plumage, modified only by wear, until a mid-winter or spring moult takes place, the second assumes a distinct first winter plumage by an early postjuvenal moult, which involves only the body feathers, the tertiaries and a few of the lesser wing-coverts. As both classes of young birds and the adults of all species undergo a prenuptial moult by which the nuptial or breeding dress is assumed, it seems desirable to speak of a prenuptial moult (rather than of a delayed postjuvenal) in birds of the first class. The facts are not altered, but we must say, for convenience, that in this class the postjuvenal moult is omitted or suppressed and the first winter plumage is simply the juvenal modified by wear.

The following are some of the species belonging to the first class, viz., American Woodcock (*Philohela minor*), Wilson's Snipe (*Gallinago delicata*), Pectoral Sandpiper (*Tringa maculata*), Solitary Sandpiper (*Totanus solitarius*), Spotted Sandpiper (*Actitis macularia*), Long-billed Curlew (*Numenius longirostris*), Killdeer (*Ægialitis vocifera*), Semipalmated Plover (*Ægialitis semipalmata*), and Turnstone (*Arenaria interpres*).

The second class includes, among others, the following, viz., Red Phalarope (*Crymophilus fulicarius*), Northern Phalarope (*Phalaropus lobatus*), Wilson's Phalarope (*Phalaropus tricolor*), American Avocet (*Recurvirostra americana*), Dowitcher (*Macrorhamphus griseus*), Long-billed Dowitcher (*Macrorhamphus scolopaceus*), Stilt Sandpiper (*Micropalama himantopus*), Knot (*Tringa canutus*), White-rumped Sandpiper (*Tringa fuscicollis*), Least Sandpiper (*Tringa minutilla*), Semipalmated Sandpiper (*Ereunetes pusillus*), Dunlin (*Tringa alpina*), Red-backed Sandpiper (*Tringa alpina pacifica*), Greater Yellow-legs (*Totanus melanoleucus*), Yellow-legs (*Totanus flavipes*), Willet (*Symphemia semipalmata*), Bartramian Sandpiper (*Bartramia longicauda*), Buff-breasted Sandpiper (*Tringytes subruficollis*), Sanderling (*Calidris arenaria*), Black-bellied Plover (*Charadrius squatarola*), and American Golden Plover (*Charadrius dominicus*).

It is evident that the feathers of the juvenal plumage must be

fully developed before the southward migration is attempted; but the occurrence of many specimens of many species far from their breeding grounds shows the serviceable nature of these feathers, which are only slightly less resistant to wear than those of adults. Here are two birds of the first class which illustrate the far southern range in juvenal dress, viz., *Tringa maculata*, Am. Mus. Nat. Hist., No. 30861, October, Brazil, and *Actitis macularia*, Am. Mus. No. 71427, September 14 Colombia; and there is a goodly number of other specimens and other species too numerous to specify from localities this side of the equator.

Birds of the second class also press far south in many cases before the postjuvenal moult sets in, as proved by a number of species, among them the following, viz., *Macrorhamphus griseus*, Am. Mus. No. 50148, July 5, Florida; *Tringa canutus*, Am. Mus. No. 26968, August 8, England; *Tringa fuscicollis*, Am. Mus. No. 34858, October 21, Brazil; *Totanus melanoleucus*, Am. Mus. No. 30859, October, Brazil; *Charadrius dominicus*, Am. Mus. No. 30856, August, Bolivia, and No. 58677, November 14, Brazil; *Charadrius squatarola*, Am. Mus. No. 61634, October 25, France and *Calidris arenaria*, Am. Mus. No. 30860, August, Bolivia, these specimens showing only the beginning of the postjuvenal moult. Usually, however, young birds of these and other species gradually assume new feathers of the winter dress as they travel towards their winter quarters. It is hardly necessary to specify them by number, for they are to be found in every collection. Some species are earlier than others, and there is considerable individual variation, but the first winter plumage is generally assumed during August and September, so that October or, at most, November specimens have completed the moult, which apparently never includes the flight-feathers nor the tail.

Adults, easily recognizable in the early autumn, at least until the postnuptial moult is completed, by the worn and scalloped-out feathers of the nuptial dress, probably leave their breeding grounds before beginning to moult and gradually assume their winter dress as they loiter here and there on their southward journey. They move southward much earlier than is generally supposed, and probably make long flights without stopping. I have examined specimens of various species taken in Cuba, Texas,

California, Mexico, and even Peru and Bolivia, which are in full worn nuptial plumage. Among others that have acquired much of the adult winter plumage may be mentioned the following, viz., *Tringa canutus* (U. S. Nat. Mus. No. 78419, ♀, September 1, Florida), retaining only four old primaries· *Actitis macularia* (U. S. Nat. Mus. No. 134832, August 28, San Clemente Island, California), with only four old primaries left; *Calidris arenaria* (U. S. Nat. Mus. No. 128793, October 8, Aldabra Island, Indian Ocean) with three old primaries, and No. 151633, July 17, Venezuela, with three old primaries; *Totanus melanoleucus* (Amer. Mus. Nat. Hist. No. 51240, ♀, July 29), Arizona, with six old primaries; *Macrorhamphus scolopaceus* (Am. Mus. Nat. Hist. No. 50585, ♂, July 5, Florida) with four old primaries; *Arenaria interpres* (G. B. Sennett, No. 5159, ♂ [=♀], July 1, Texas), the distal or first primary still a pin point, the second just out of its follicle, the remainder full grown, while the third primary of each wing and the proximal secondaries are still pulpy.

The beginning of this postnuptial moult, as well as of the postjuvenal, is shown by birds in almost every collection, the first feathers appearing on the humeral tracts, near their middle, and later, on the back and at either side of the breast. These feathers are fairly large, but come from very small follicles, so that the sheaths do not persist long and are often lost in the process of skinning, as I have learned by experience. The body feathers seem to come in less rapidly and more irregularly than with Passerine species, so that it is extremely easy to overlook their moult in studying dried skins. The renewal of the body feathers seems generally to be in advance of the remiges at the postnuptial moult, and to follow them at the first prenuptial. The tenth or proximal primary of each wing falls first, followed quite leisurely by the more distal, moult beginning among the secondaries with the distal member when only three or four old primaries are left. The inner secondaries, better known as tertiaries, precede the proximal primaries. The greater coverts, and a band of the lesser coverts near the anterior edge of the wing, also precede them. The rectrices are not renewed as a rule before nearly all of the primaries have been replaced. The last feathers to be renewed are those of the chin, sides of head and mid-abdomen. A few

winter specimens with the outer primaries much more worn than the inner seem to point to the checking of moult in some cases and this failure to moult at the proper time is much more common in body feathers.

Few birds taken on the North Atlantic coast show moult of the remiges in progress, but many species in collections, those in my own collection represented by specimens studied while fresh, show renewal of the body feathers by the postnuptial moult which, as proved by southern specimens, is usually completed in August or September. The adults of species with a postjuvenal moult begin moulting earlier than young birds, a fact which may account in part for the migration of males earlier than the females and young, just as in Passerine species. My experience for years has been that the birds seen in July and early August are largely adults, and intelligent gunners everywhere tell the same story. Later than October it is not easy to distinguish old from young unless the latter retain here and there distinctive feathers of the juvenal plumage, or the former retain a few feathers of the nuptial dress. A few tell-tale feathers remaining until a later period of moult are invaluable in fixing age, for plumage differences between young and old in winter are slight and inconstant as a rule, although more marked in some species than in others.

The amount of wear shown by the plumage varies with the individual, and black feathers outwear those of any other color. The primaries and secondaries show so little wear that even the microscope will not demonstrate how much newer one feather is than another without other evidence, but the finding of growing feathers often confirms the testimony of worn plumage, and it is upon the testimony of such 'blood-feathers,' as they have felicitously been called, that all my conclusions are based.

There is abundant evidence that adults and young both undergo a prenuptial moult which certainly involves the body plumage of both; in young birds of many species the moult is complete, except perhaps in the case of some females; in adults it does not seem to include the remiges nor the rectrices.

Comparatively few specimens show winter moult of the remiges, but among them may be mentioned the following, viz., *Crymophilus fulicarius* (U. S. Nat. Mus. No. 86423, February 21, Lower

California), with the three proximal primaries growing, and no new body feathers as yet; *Tringa fuscicollis* (U. S. Nat. Mus. No. 116227, ♀, January 16, Gregory Bay, Patagonia) the primaries new except the first, the middle pair of rectrices new, but no new body feathers; *Actitis macularia* (U. S. Nat. Mus. No. 169037, ♀, February 9, Culebra Id., W. I.), retaining one old primary, the old tail and old body plumage; *Charadrius squatarola* (Amer. Mus. Nat. Hist. No. 39072, ♀, February 27, Florida), with two old primaries remaining, together with old tail and body plumage; and other specimens, with incomplete data, which confirm the evidence of those cited. It is possible, although not probable, that some of these are adults, but the plumage seems to indicate young birds, and the rarity of adults at any season is an argument against their being adults. At all events, a moult begins in January or February, and there are many specimens of many species which show growth of new body feathers later in the winter. April specimens are often in the midst of moult or at the end of it, some of them with fresh remiges and rectrices, and others with them evidently much worn. My impression is that the more worn birds are adults, the fresher ones young birds which complete their moult earlier. The probability also is that species with a postjuvenal moult are later in consummating the prenuptial, but the material available does not furnish conclusive evidence upon these points. The numerous specimens in worn winter plumage showing no evidence of moult during February need not be cited. As adult females are indistinguishable from young males at this season, and adult males are not conspicuously different, the difficulty of drawing conclusions from them, even after the beginning of the prenuptial moult, becomes apparent.

In addition to the young birds just cited there are some others which illustrate the onset of this moult presumably in adults, viz., *Tringa alpina pacifica* (U. S. Nat. Mus. No. 102142, ♂, March 29, Japan), with worn wings and tail, but new 'blood-feathers' scattered on the body; another (No. 154206, May 10, California) still showing new feathers in the new plumage; *Calidris arenaria* (Amer. Mus. Nat. Hist. No. 45580, ♂, April 13, California), with new 'blood-feathers' on the body at various points; another (No. 60007, ♀, April 30, Florida) more advanced,

the wings and new tail indicating probably a young bird; *Macrorhamphus scolopaceus* (Amer. Mus. Nat. Hist. Nos. 49438, ♀, and 49439, ♂, March 10, California), with new body feathers just appearing; *Tringa minutilla* (Amer. Mus. Nat. Hist. No. 59511, ♀, April 22, Trinidad, W. I.), still chiefly in winter dress; and *Ægialitis semipalmata* (Am. Mus. Nat. Hist. No. 29850, ♂, April 14, South Carolina), with a few new feathers. These are only a small part of the specimens that might be cited in proof of the occurrence of a prenuptial moult in both young and old, and further evidence may be found in May specimens which are in fresh new plumage except for such feathers as fail to moult. A smaller number of these are to be found on birds that appear to be adults, a greater number on young ones, and females regularly renew fewer feathers than males of like age.

In the foregoing pages, I have outlined the facts, as we find them, concerning the moulting of the Shore Birds, but in order to emphasize and bring them out still more clearly, I purpose taking up a few familiar species and tracing their moults and plumages in natural sequence.

SPOTTED SANDPIPER (*Actitis macularia*).

1. *Natal Down.* This is well developed before the bird leaves the egg, forming a dense, continuous clothing. Above, the filaments or neossoptiles are partly banded with black and pale brown, producing a mottled olive-gray appearance, and partly black, producing the median stripe from the bill to the tail. Below, they are white, those of the sides of the head buff-tinged except a black loral and postocular streak. The anterior border and extremity of the wing and the orbital ring are white.

Many specimens from different localities illustrate this stage. Two in my own collection (J. Dwight Jr., No. 1221, June 21, New York; and No. 3612, July 6, Prince Edward Island, Canada) are typical examples.

2. *Juvenal Plumage* acquired by a complete postnatal moult, the down filaments being really a continuation of the apical barbs of the succeeding feathers, in most cases, but not found at the

apices of the remiges. This stage is characterized by the olive-green upper surface, the feathers of the back especially being edged with buff and having a subterminal bar of dull black, those of the wing-coverts with a second indistinct bar. Below, pure white prevails, with gray on the sides of the throat.

The growth of this plumage may be traced during July and early August, males and females being indistinguishable. One of my birds (J. D. Jr., No. 4123, July 7, Quebec) shows remiges about two thirds grown, the rectrices about one third and with the down still attached, which also adheres to new feathers of the crown, back, and sides of breast; on the forehead, sides of head, the nape, throat and mid-abdomen the down has not yet been displaced. Another (J. D. Jr., No. 6437, August 5, Nova Scotia) with grown but pulpy outer primaries, is so advanced that down only remains on the chin, the bird being fully feathered. Another (J. D. Jr., No. 6812, July 15, New York) is still more advanced, with few traces of immaturity.

As adults at their postnuptial moult assume a dress scarcely distinguishable from this, I can only point out some differences that unfortunately do not hold in all cases, especially in females. Young birds are practically without dusky shaft-lines on the feathers of the throat, the barring of the back and wing-coverts is duller, the tertiaries lack the dusky blotches of the adult and the outer pairs of rectrices are less distinctly white and blotched more irregularly with duller black.

In both young and adults, wear soon begins to change the appearance of this dress, which is usually called the autumnal plumage. Not only do the buff edgings fade, but the feather tips break away until even the subterminal barring is lost, except on the wing-coverts where the second bar is retained late into the winter. August specimens, from the Atlantic coast as well as from Arizona, show gradual loss of the edgings. Two specimens in my collection (J. D. Jr., No. 6814, September 5, New York and No. 6695, September 1, Quebec) still retain most of the buff edgings, although much faded, while two others (J. D. Jr., No. 386, August 26, Connecticut, and No. 6816, September 18, New York) have almost completely lost even the dusky bars. The southern range while in this plumage is shown by a somewhat

worn specimen from South America (Am. Mus. Nat. Hist. No. 71427 September 14 Colombia).

3. *First Winter Plumage* acquired apparently wholly by wear, by which the upper parts become uniformly olive green *without edgings* except a few dusky bars on the wing-coverts. It is convenient to call this stage the winter dress, and to consider the postjuvenal moult as suppressed in this species. There are many Passerine birds in which the nuptial or breeding plumage is simply the autumnal dress modified by wear, and if we are justified in calling a worn autumnal or winter plumage, the breeding dress of these birds, so we are justified in calling a worn juvenal plumage, the first winter plumage. Whatever we choose to name it, it is worn at least until the beginning of January, as proved by numerous October, November and December specimens, of which, among many with incomplete data, I may cite the following as apparently young birds: Amer. Mus. Nat. Hist. No. 51294, ♂, December 8, Arizona; U. S. Nat. Mus. No. 86420, ♀, January 6, Lower California; U. S. Nat. Mus. No. 120277, ♀, January 3, Honduras.

4. *First Nuptial Plumage* acquired by a prenuptial moult probably complete, as indicated by a number of specimens, some unfortunately without dates. While it is possible that some of these birds which show actual feather growth, especially of the remiges, are adults, it is not at all probable, judging by their plumage and by the usual scarcity of adults at any season. The following serve to prove the occurrence of a complete moult, viz., U. S. Nat. Mus. No. 169037, ♀, February 9, Culebra Island, has renewed the primaries, except the worn distal one, the rectrices and body plumage being mostly old and worn; U. S. Nat. Mus. No. 74051, ♂, February, St. Vincent Island, West Indies, retains two old distal primaries, tail and body plumage; U. S. Nat. Mus. No. 81016, ♂, [no date], St. Thomas Island, W. I., has the remiges and part of the rectrices still in their sheaths, and new nuptial feathers among those of the worn body plumage; and U. S. Nat. Mus. No. 80973, ♂, [no date] St. Eustatius Island, W. I., retains still four old primaries, but new body feathers are growing at several points.

Specimens in abundance from Florida and Arizona, taken in

April, are in fresh new plumage, indicative of recent moult, and some of them occasionally show 'blood-feathers.' One (Am. Mus. Nat. Hist. No. 34844, April 1, Brazil), with fresh remiges and rectrices and a sprinkling of half-grown body feathers, indicates the practical completion of the prenuptial moult before winter quarters have been abandoned.

In this, the breeding plumage, males and females are usually to be distinguished, males being more extensively spotted on the white lower parts. The spots are subterminal, so that wear first removes the white tips, and later on much of the black which, late in the summer, assisted by fading, may nearly disappear from the throats, in some cases, as well shown by one of my birds (J. D. Jr., No. 3938, ♂, August 19, Quebec). The barring of the back in the nuptial dress is so heavy on each feather and so far removed from its apex, that it is only lost in excessively worn specimens, as shown by another of my birds (J. D. Jr., No. 4171, ♂, July 29, Quebec).

5. *Second or Adult Winter Plumage* acquired by a complete postnuptial moult accomplished in August or September.

Adults, as birds may now be called, either move south in the autumn before moulting or possibly take such good care of themselves while moulting that few find their way into collections. Some reach Cuba (U. S. Nat. Mus. No. 23601, September 3) and Mexico (U. S. Nat. Mus. No. 57709, August 14) without moult, while others, taken far from their breeding grounds, show the postnuptial moult in progress, viz., U. S. Nat. Mus. No. 134832, August 28, San Clemente Island, California, still retains four old primaries and all of the tail except the middle pair of rectrices which are sprouting; Amer. Mus. Nat. Hist. No. 30863, August, Bolivia, which has five old primaries, the rest being new as well as the rectrices (except the outer pair) and the greater coverts; and two birds No. 71426, September 13, and No. 71428, September 14, Colombia, showing extensive moult of the body plumage.

The plumage acquired resembles closely the juvenal, under which the slight average differences have been noted, and wear soon fades and removes the buff edgings as in the young bird.

6. *Second or Adult Nuptial Plumage* acquired by a prenuptial moult which undoubtedly includes the body-feathers, tertiaries,

and a few of the lesser coverts, but apparently not the remiges nor the rectrices. I have already discussed the evidence which proves a moult in adults as well as young birds, the late winter specimens with worn wings and tails indicating either adults or possibly young females. One specimen may be cited in full winter dress at a late date (U. S. Nat. Mus. No. 133016, March 19, [Arizona ?]).

The following species has a distinct postjuvenal moult.

SANDERLING (*Calidris arenaria*).

1. *Natal Down.* Not seen by me.

2. *Juvenal Plumage* acquired by a complete postnatal moult. This plumage is much washed with buff, the edgings of many of the feathers distinctly buff, including those of the sides of the breast, the tint fading quite rapidly. A bird (Am. Mus. Nat. Hist. No. 60751, ♀, August 20, Labrador) of fresh plumage illustrates this stage.

3. *First Winter Plumage* acquired by a partial moult which includes the body plumage, tertiaries, and wing-coverts but not the remiges nor rectrices. A wholly gray plumage, white below, is assumed and, save for left-over tell-tale feathers, especially tertiaries, young birds become practically indistinguishable from adults that have completed their postnuptial moult, although the feathers of young birds are paler centrally and therefore with less obvious shaft-streaks. September and October specimens in every collection show the gradual growth of the gray body feathers and one from Bolivia (Amer. Mus. Nat. Hist. No. 30860, August) shows that this far southern locality may be reached before the moult is far advanced. Another specimen (U. S. Nat. Mus. No. 161921, October 1, Virginia) is largely in first winter dress; also one (G. B. Sennett, No. 404, ♂, November 1, Pennsylvania) and one (Am. Mus. Nat. Hist. No. 64551, ♀, November 9, Lower California), possibly an adult, is wholly gray. Among winter specimens of young birds, determined by retained juvenal feathers, especially dusky-tipped tertiaries, the buff edgings of which fade to white, are the following, viz.; U. S. Nat. Mus. No. 163525, January 9, California; No. 102063, Jan-

uary, Heligoland Id., and Amer. Mus. Nat. Hist. No. 64542, ♂, January, Heligoland Id. Several much worn February birds that may be either young birds or adults are still in full winter dress.

4. *First Nuptial Plumage* acquired by a prenuptial moult that appears to be complete, although possibly not in females. The reddish dusky barred feathers of the throat are assumed with the black, gray or rusty edged feathers of the back, young and old being practically indistinguishable although adults are richer in color and there are fewer winter feathers left behind when the moult is completed. Several specimens illustrate different stages, viz.: Am. Mus. Nat. Hist. No. 49827, ♂, April 19, Florida; No. 45485, ♀, April 13, California; No. 60007, ♀, April 30, Florida, all showing 'blood-feathers' of the body plumage and of the rectrices to a greater or less degree.

5. *Second or Adult Winter Plumage* acquired by a complete postnuptial moult in July, August, September and October. Many August and September specimens show new gray winter feathers creeping in on the back while new white ones below gradually efface the reddish colors. As early as July 7 one specimen (U. S. Nat. Mus. No. 151633, Venezuela) is largely in winter dress, retaining only three old primaries, while another (U. S. Nat. Mus. No. 102064, ♂, October 31, Peru) still retains five old primaries. Two birds (U. S. Nat. Mus. Nos. 128793 and 128795, October 8, Aldabra Id., Indian Ocean) are in the midst of moult, retaining three distal primaries, the others, with most of the body plumage and the inner pairs of rectrices being new. The full winter dress, which differs very little from that of young birds, is shown by various specimens; U. S. Nat. Mus. No. 128796, November 10, Aldabra Id., Indian Ocean; G. B. Sennett, No. 3938, January, Texas; Amer. Mus. Nat. Hist. No. 39075, February 23, Florida (possibly a young bird).

6. *Second or Adult Nuptial Plumage* acquired by a prenuptial moult that involves the body plumage and part of the wing-coverts but apparently not the remiges nor rectrices. An undoubted adult (Amer. Mus. Nat. Hist. No. 45580, ♂, April 13, California) is instructive, retaining a few feathers of the previous nuptial dress, much worn, part of the winter dress less worn, and with new body feathers growing at many points. A similar spec-

imen (G. B. Sennett, No. 3685, ♀, March 28, Texas) may also be cited. The full plumage may not be acquired until early in May.

Another species that has the same sequence of moults and plumages as the Sanderling, is the Dunlin which may well be considered along with its North American representative.

DUNLIN *(Tringa alpina).*

RED-BACKED SANDPIPER *(Tringa alpina pacifica).*

1. *Natal Down.* The chick above has rusty and golden brown and black mottling, with small white dots. The mixed colors are due to banded down filaments or neossoptiles and the spotting to subterminal white areas. Below, including cheeks and forehead, the neossoptiles are buffy white, a dusky loral and postocular streak and a fainter malar one.

2. *Juvenal Plumage* acquired by a complete postnatal moult. It is not generally known that birds in this plumage are quite heavily spotted below with black, the back with reddish and buff edgings, and a buff wash on the throat, so that they much resemble adults in breeding dress. I have examined several July and August birds from Alaska, a perfectly typical one, still retaining a little down on the head and neck being (U. S. Nat. Mus. No. 88881, August 3, Pt. Barrow, Alaska).

3. *First Winter Plumage* acquired by a partial postjuvenal moult involving the body plumage, sometimes all, and sometimes part of the tertiaries, a few of the wing-coverts but neither the remiges nor rectrices. The gray plumage, white below, is assumed, scarcely distinguishable from adults in winter dress, but the central part of the dorsal feathers is usually paler than in adults, likewise the gray shaft-streaks of the throat and sides. Left-over juvenal feathers are often found, and the black-spotted ones of the lower parts become faded and worn and may easily be mistaken for those of the adult. This plumage is fully assumed by October, as shown by many specimens from many localities, numerous November and December birds showing little evidence of further moult, viz.: Am. Mus. Nat. Hist. No. 69813, ♂, October 16, New

York; No. 64972, ♀, October 19, New York; No. 47255, ♂, November 11, Washington; No. 26963, ♂, November 25, France; No. 45544, November, Texas; No. 64535, December 20, Denmark; and J. Dwight Jr. Nos. 674, ♀, 675, ♂, and 676 ♀, November 24, Delaware.

Mid-winter specimens are few and show no signs of the prenuptial moult, which evidently takes place later. The juvenal tertiaries, when retained, lose their buffy edgings and dusky tips by wear and so this distinguishing character between young and old is often obliterated. One specimen (J. Dwight Jr. No. 4897, January, California) is certainly a young bird.

4. *First Nuptial Plumage* acquired by a prenuptial moult that is apparently complete. March and April specimens regularly show growth of the new body plumage; but it is not easy to distinguish adults from young, even in winter plumage, and they become indistinguishable at the first prenuptial moult. The wings and tails of adults are usually much worn. The fresh plumage is dull black above with rusty edgings and gray feather tips; below, white spotted with black and veiled with white edgings, the spotting in males so heavy on the abdomen that a black area is produced by loss of the edgings, which wear away rapidly.

The following specimens illustrate this moult, viz.: U. S. Nat. Mus. No. 102142, ♂, March 29, Japan; Am. Mus. Nat. Hist. No. 26962, ♀, March 23, France; No. 45543, ♂, April, California; No. 55008, ♂, April 25, Texas.

The incompleteness of the prenuptial moult, especially in females, is shown by a scattering of winter feathers found on summer birds, and when at the postnuptial moult new feathers are added to those of two other periods of growth, fine opportunity is afforded for those who would theorize about wonderful color changes and restorations.

5. *Second or Adult Winter Plumage* acquired by a complete postnuptial moult, occurring earlier than the postjuvenal of young birds, but in adults as well as young an almost identical plumage is assumed. A bird, U. S. Nat. Mus. No. 102125, ♂, August 14, Petchora River, Russia, retains six old primaries of the nuptial dress and new body feathers are growing, while No. 162593, ♂,

September 7, North China, has renewed the flight feathers and only part of the body plumage. Among the many specimens examined in the gray and white dress, which results from this moult, there are few that can be identified with certainty as adults, both young and old, males and females, being practically indistinguishable in winter dress.

6. *Second or Adult Nuptial Plumage* acquired by a prenuptial moult which does not appear to involve the wings nor the tail with the exception of the tertiaries and a few wing-coverts. What has already been said of the first nuptial plumage applies equally well to the second or third, and the specimens there mentioned may, some of them, be adults. One other that I believe to be an adult (Amer. Mus. Nat. Hist. No. 29888, ♂, April 13, South Carolina) is acquiring new body feathers, the wings, tail and tertiaries much worn.

Two other species that on account of similarity of plumage may well be considered together are the following:

AMERICAN GOLDEN PLOVER (*Charadrius dominicus*).

BLACK-BELLIED PLOVER (*Charadrius squatarola*).

1. *Natal Down.* Mottled above, yellowish below.

2. *Juvenal Plumage* acquired by a complete postnatal moult. Extra-limital specimens of *C. dominicus* in this plumage are the following, viz.; Am. Mus. Nat. Hist. No. 30856, August, Bolivia, and eight birds from Brazil taken between October 5 and November 14. Specimens of *C. squatarola* are the following, viz.: Am. Mus. Nat. Hist. No. 61634, ♂, October 25, France; No. 61633, November 9, Amoy, China; U. S Nat. Mus. No. 119351, ♂, December 26, West Indies.

3. *First Winter Plumage* acquired by a partial postjuvenal moult late in the fall which involves only the body plumage. No. 61634 just cited shows an early stage. The winter dress is deep gray above (yellow-tinged in *C. dominicus*) and chiefly white below, indistinctly mottled on the breast and not differing greatly in the two species.

4. *First Nuptial Plumage* acquired by a prenuptial moult that is

practically complete except perhaps in some females. Only one specimen (*C. squatarola*, Am. Mus. Nat. Hist. No. 39072, ♀, February 27, Florida) shows actual moult of the primaries, this bird having renewed all but the two distal, a few nuptial body feathers are growing, the tail is old. Another specimen of *C. squatarola*, however (U. S. Nat. Mus. No. 161033, February 16, Philippine Islands) has fresh wings and part of the body feathers are new and a specimen of *C. dominicus* (Am. Mus. Nat. Hist. No. 67499, ♀, March 26, Texas) is quite similar although it is possible they are both adults.

The results of this moult may be seen in many spring and early summer specimens, the old gray winter feathers, which are most abundantly retained in females, scattered through the black of the lower parts and less conspicuously on the back among the golden spotted nuptial feathers of *C. dominicus* or the white-tipped ones of *C. squatarola.*

5. *Second or Adult Winter Plumage* acquired by a complete postnuptial moult. Many August and September specimens show new gray feathers creeping in among the dark ones of the nuptial dress, *C. squatarola* apparently beginning to moult earlier than *C. dominicus*. A specimen of *C. dominicus* (Am. Mus. Nat. Hist. No. 30855, August, Bolivia) shows an early stage, neither the remiges nor the rectrices as yet involved, and indicates that these feathers, as in other species, are later than those of the body. It is not surprising that no specimens showing their moult have found their way into collections for winter adults of all species are surprisingly rare.

6. *Second or Adult Nuptial Plumage* acquired by a prenuptial moult which evidently includes the body feathers but apparently not those of the wings and tail. The difficulty of distinguishing adults from young, added to imperfect data, makes me hesitate about citing several specimens with worn flight-feathers that show growth of new body feathers, but the evidence that new body plumage is assumed by moult is conclusive if we examine birds even in worn breeding dress.

A few specimens of *Charadrius pluvialis* indicate precisely the same sequence of plumages and moults here outlined.

It is only a matter of suitable specimens and of time, for the

plumages and moults of other species to be worked out as I have done with the few here recorded, which have been selected to show that natural moult and wear are the cause of plumage differences. The Golden Plover, the Sanderling and the Dunlin have long been cited as proof of strange and wonderful color changes without moult. If there remains now a peg on which to hang such belief, I fail to discover it, and commend to the theorists the facts above presented which they have ignored in constructing their theories. They have started with the eminently unphysiological assumption that a grown feather *can* absorb fresh coloring matter, they have failed to recognize seasonal plumage differences between adults and young, males and females and they have supposed that the parti-colored feathers, which regularly grow on the dividing line between light and dark areas, were in process of recoloration.

In a word they have failed to recognize consecutive moults and their effects, and I trust that my present contribution to the subject will serve to open the eyes of those who imagine they see fresh colors developing in old feathers.